

The CAUSES Project – The role of precipitation and surface energy budget

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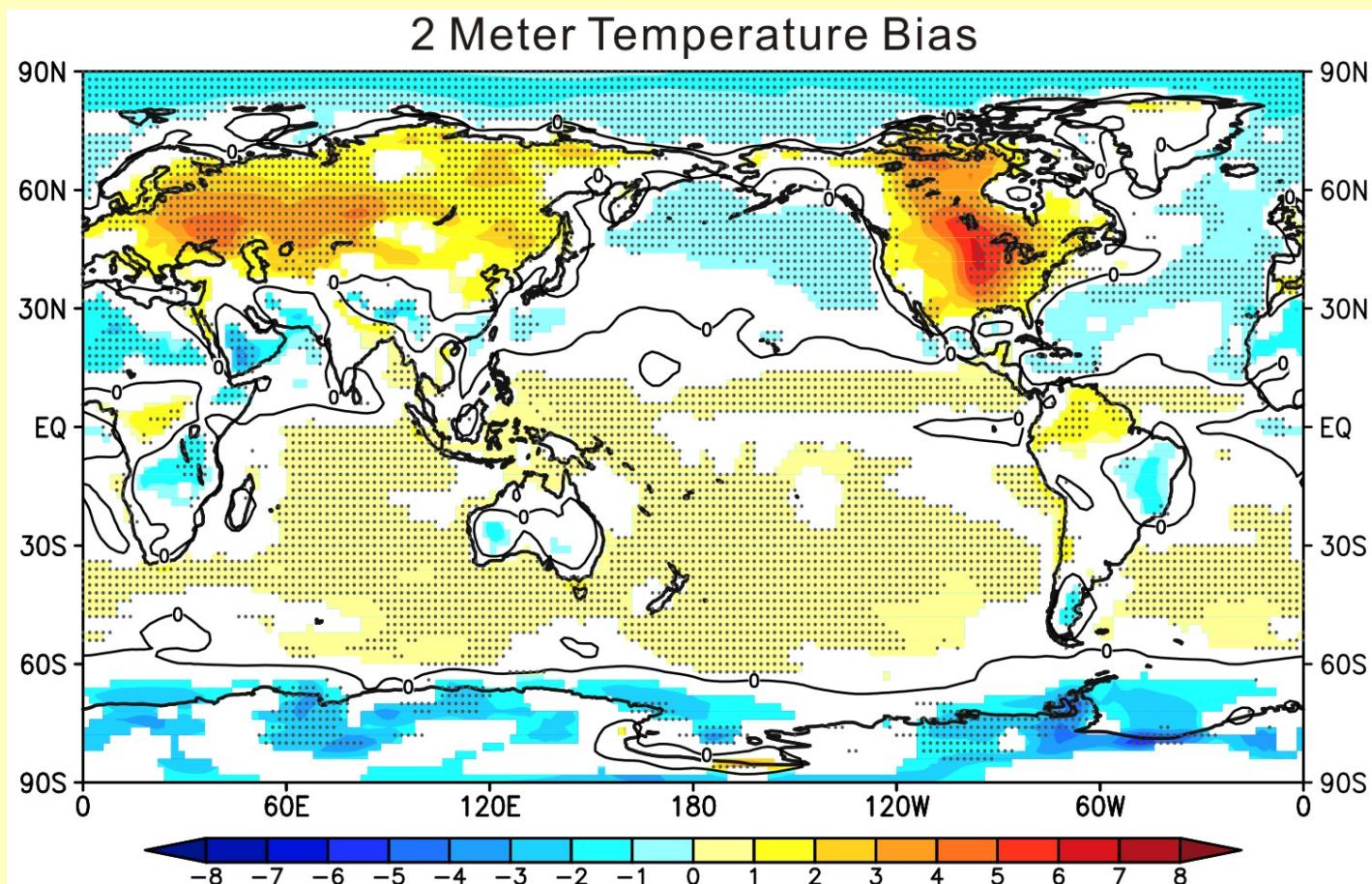


LLNL-PRES-657612

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Large summertime near surface warm bias over mid-latitude continents



- CMIP5/AMIP vs Transpose AMIP II (Ma et. al. 2014, JCLI)



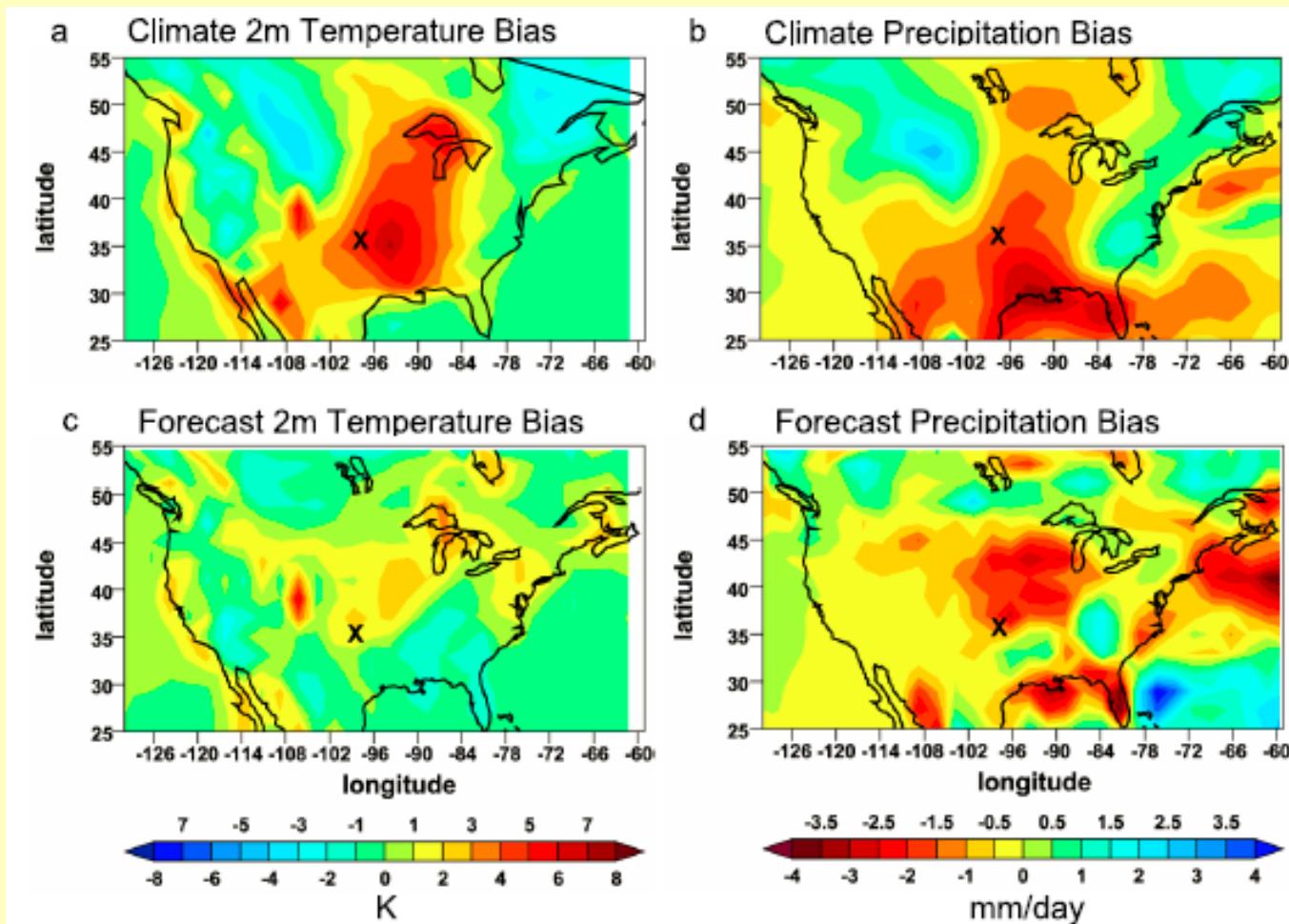
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- Warm and dry biases examined by GFDL AM2 (Klein et. al. 2006, GRL)



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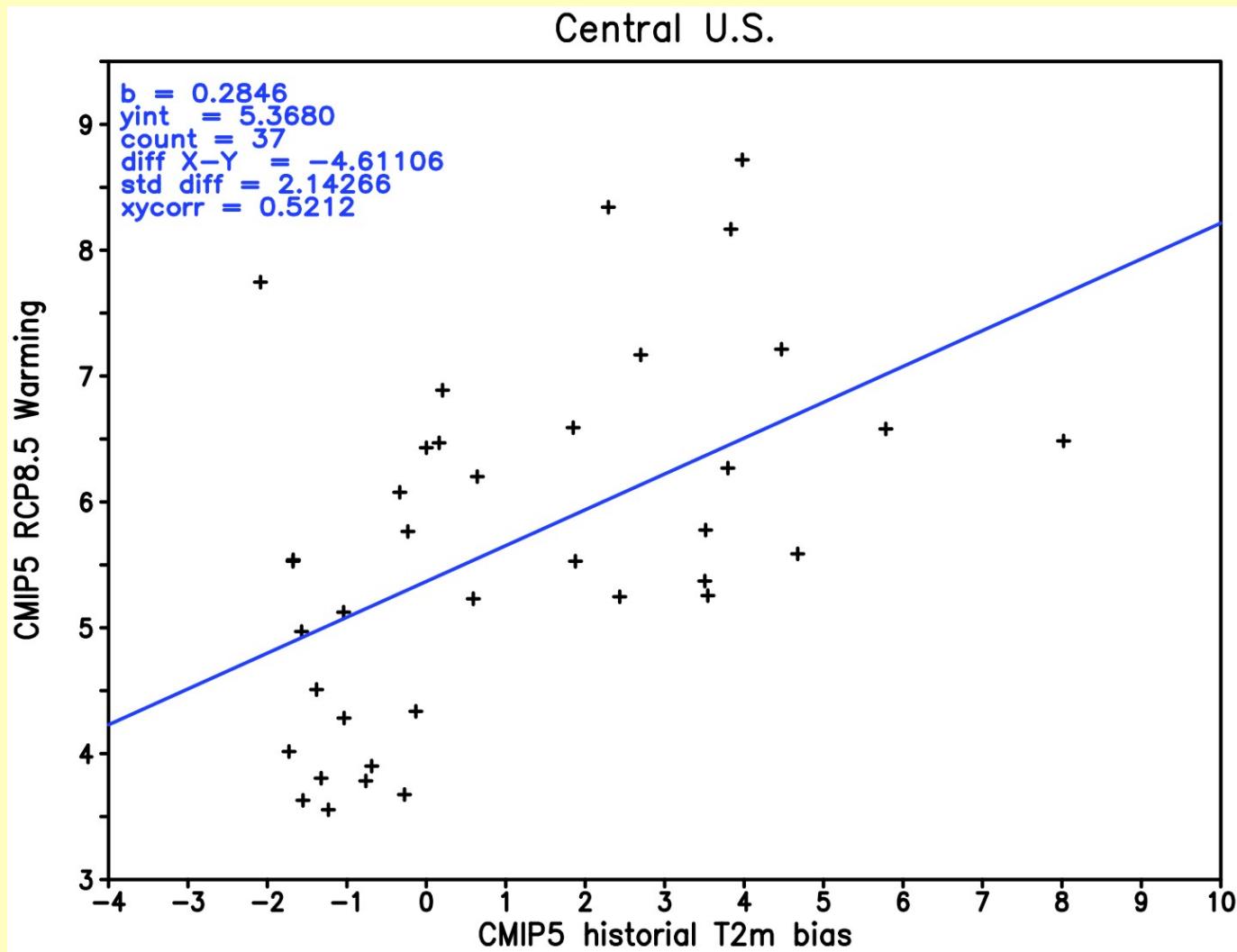


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Why T2m bias matters?



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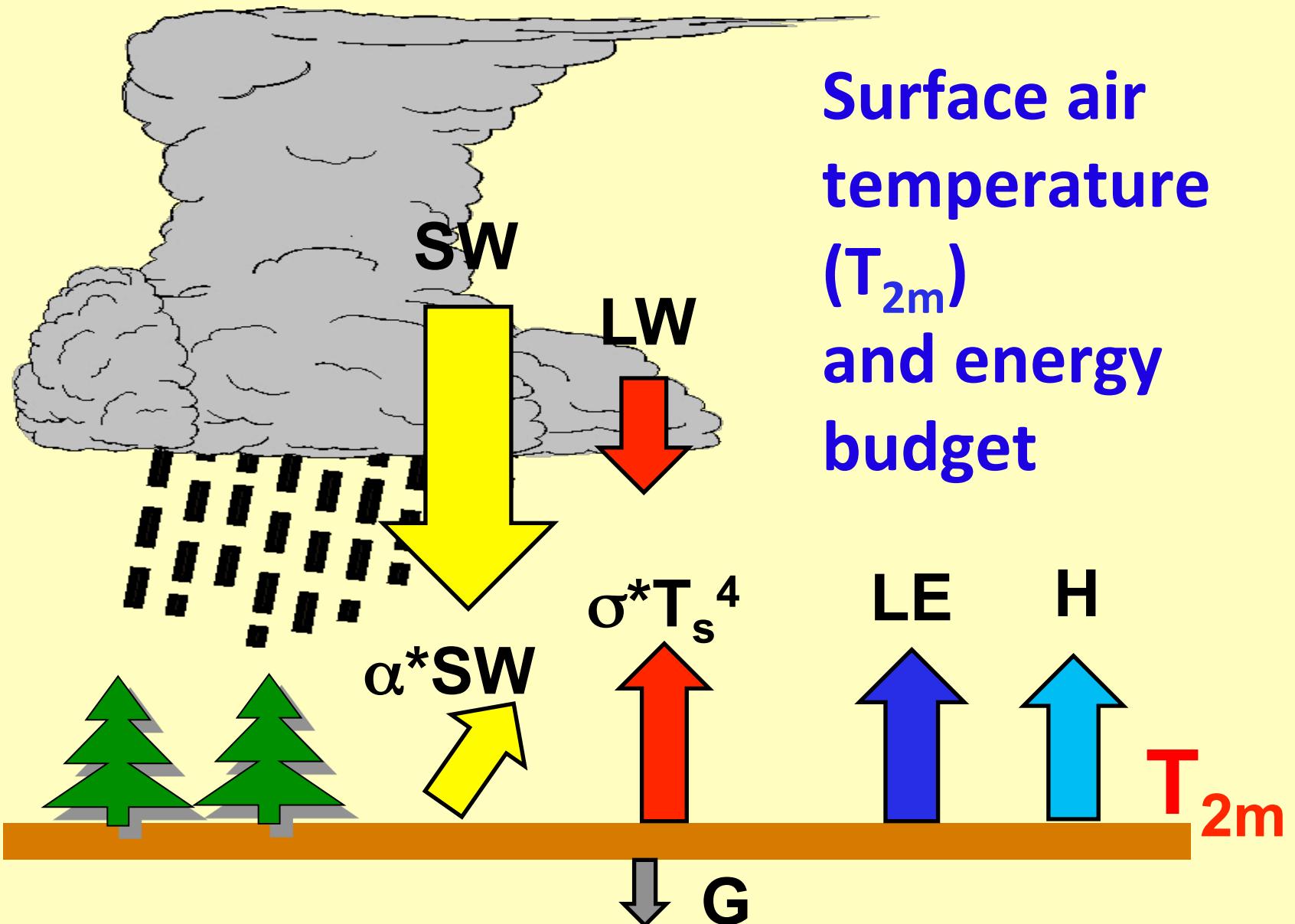


ARM
Atmospheric Radiation Measurement



CAPT
Cloud-Associated Parameterizations Tested

Surface air temperature (T_{2m}) and energy budget



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Hypotheses:

Potential issues include:

- The diurnal cycle of convection,
- Organization and propagation of convection,
- Timing of precipitation and how much evaporates,
- Radiative impact of convective cores, detrainated cloud and anvils,
- Shallow convection,
- Surface fluxes,
- Soil moisture,
-



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ASR
Atmospheric System Research



ARM
Atmospheric Radiation Measurement



CAPT
Cloud-Associated Parameterizations Testbed

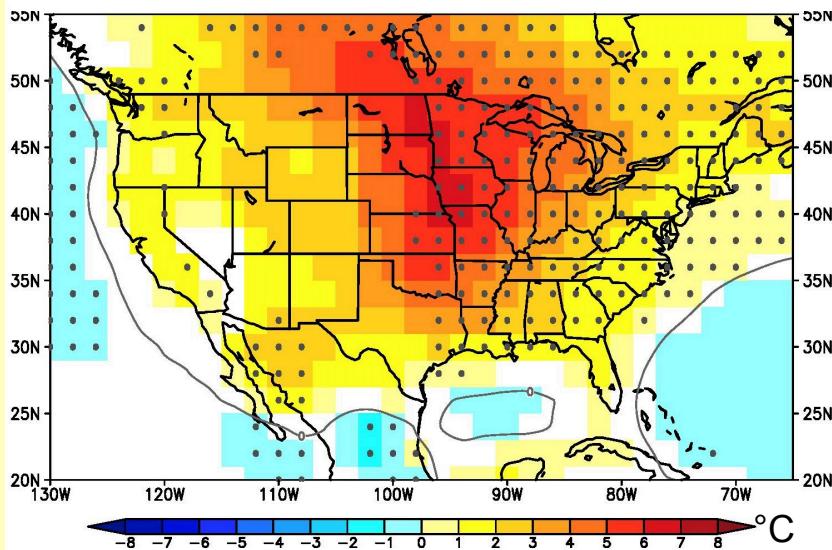
Clouds Above the United States and Errors at the Surface (CAUSES)

Purpose

A joint GASS-RGCM-ASR model intercomparison project aiming to determine the role of radiation and precipitation errors in temperature biases in climate models



Summertime 2 meter temperature bias in climate models



Research Foci

1. Radiation errors – particularly due to clouds
Led by Met Office: Cyril Morcrette, Kwinten Van Weverberg and Jon Petch
2. Precipitation and surface energy budget errors
Led by LLNL: Hsi-Yen Ma, Steve Klein, Shaocheng Xie

Methods

Error growth will be diagnosed in hindcast simulations from a variety of 1-10 km resolution limited area models and 10–100 km resolution global climate models

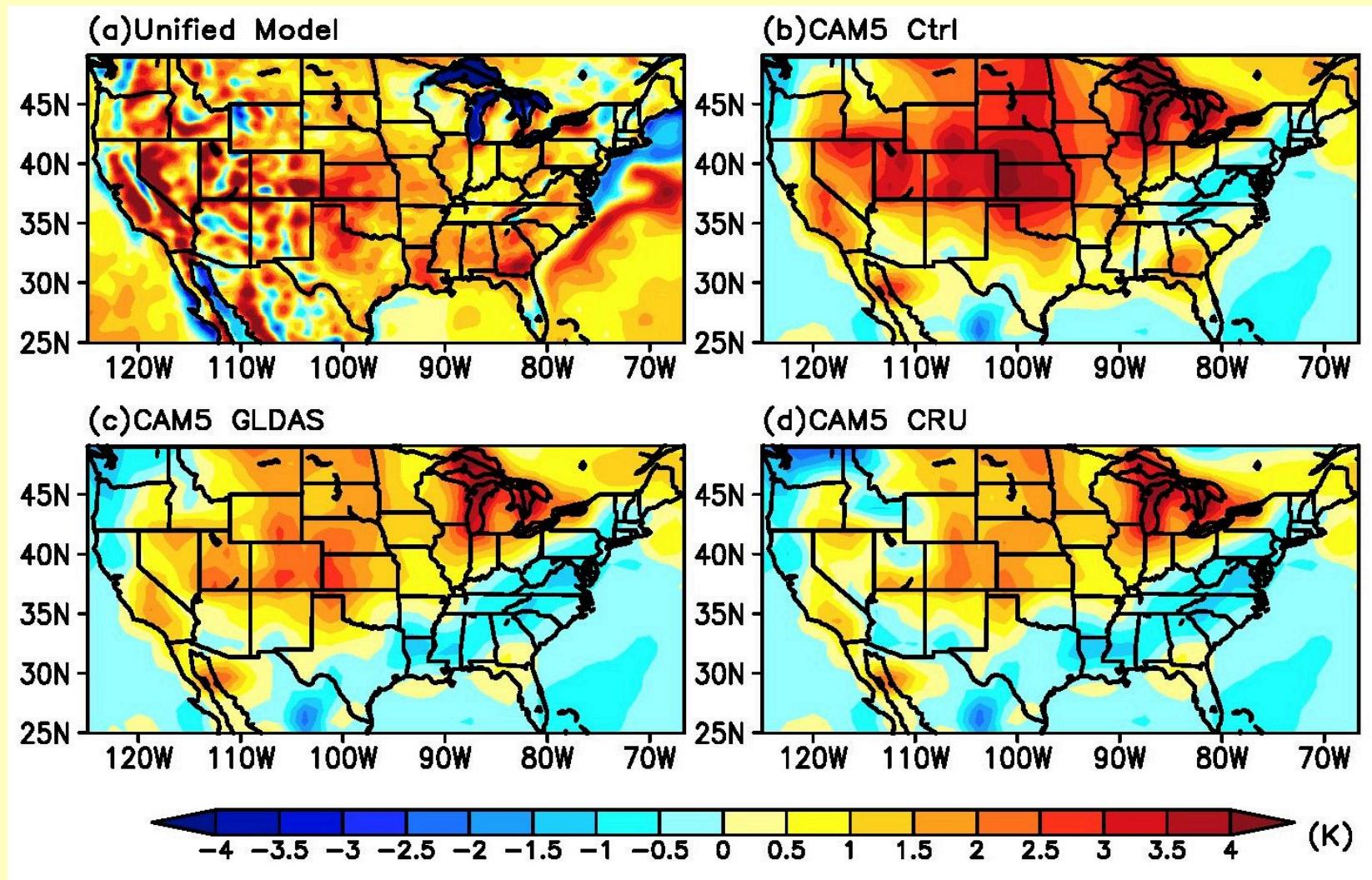
Scientific Questions?

- What is the relative contribution of precipitation errors to the temperature errors?
- Which type of precipitating convection systems dominate the errors in the surface precipitation?
- Does this atmosphere provide the correct amount of precipitation for the soil?
- Does the surface energy balance reveal signs that evaporation is underestimated due to the lack of soil moisture?

Model experiments

- Models:
 - Met Office GA6.0 (N512)
 - CAM5.1 FV (0.9x1.25L30) with 3 different land initial conditions
 - Ctrl: Nudging method from Boyle et al. (2005)
 - Two offline CLM runs with GLADS and CRU forcing data
- Experiments: 5-day long short-term hindcasts for April-August 2011 starting everyday at 00Z (additional June-August 2008 hindcasts for CAM5)

T2m Bias (Day 2 hindcast ensemble of May 2011)



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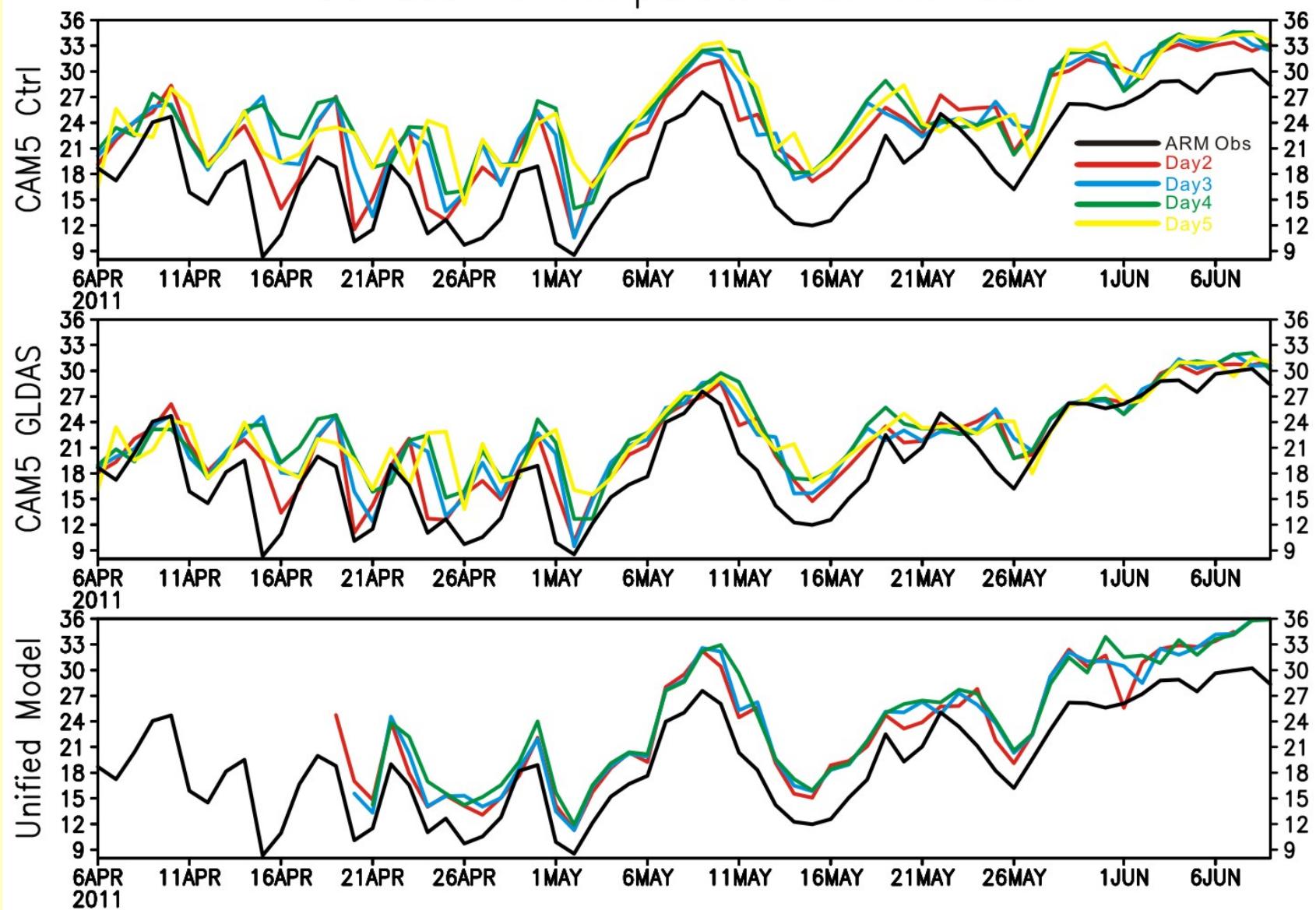


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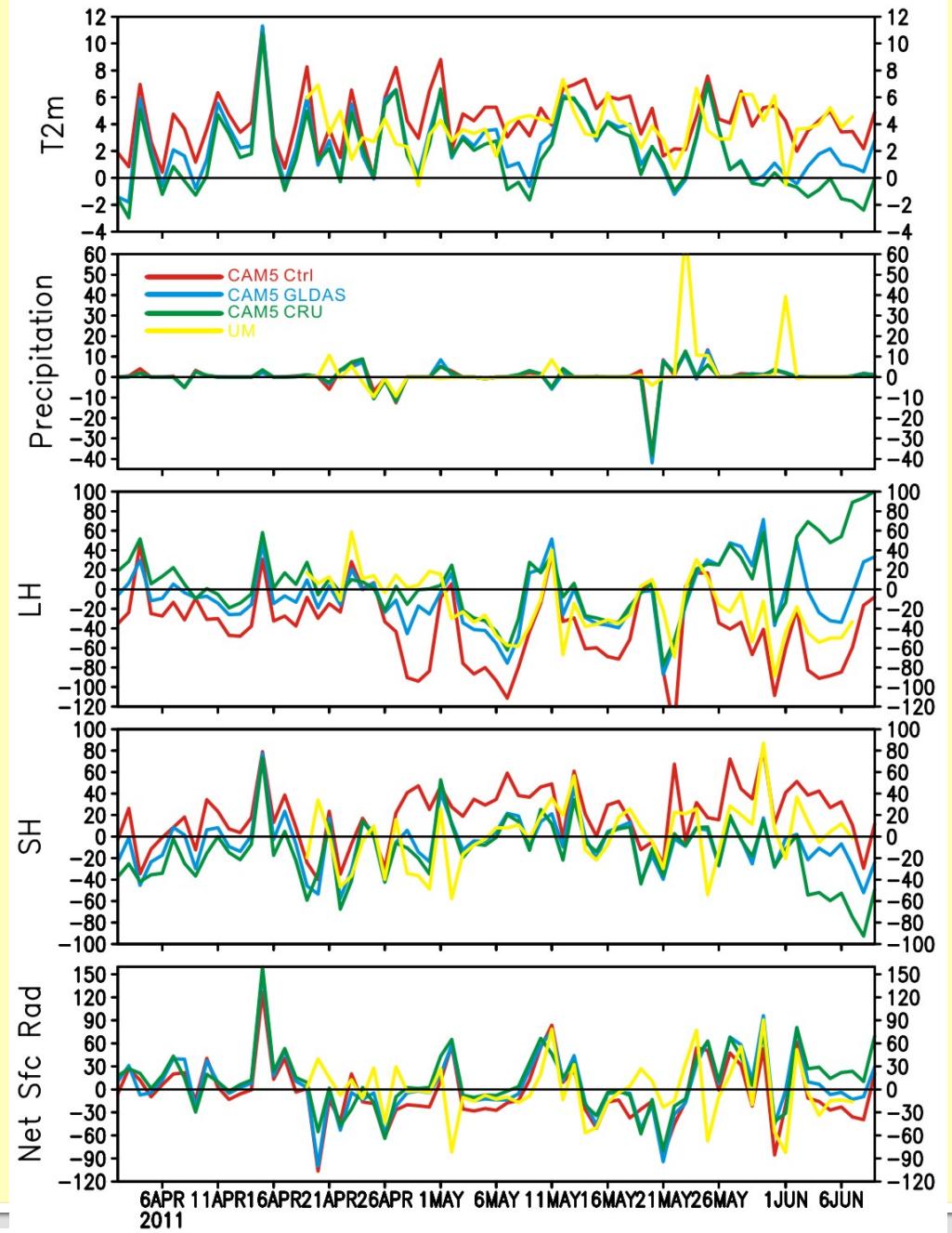
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Surface Air Temperature at ARM SGP



Surface Fluxes examined by ARM observations at SGP



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Scientific Questions?

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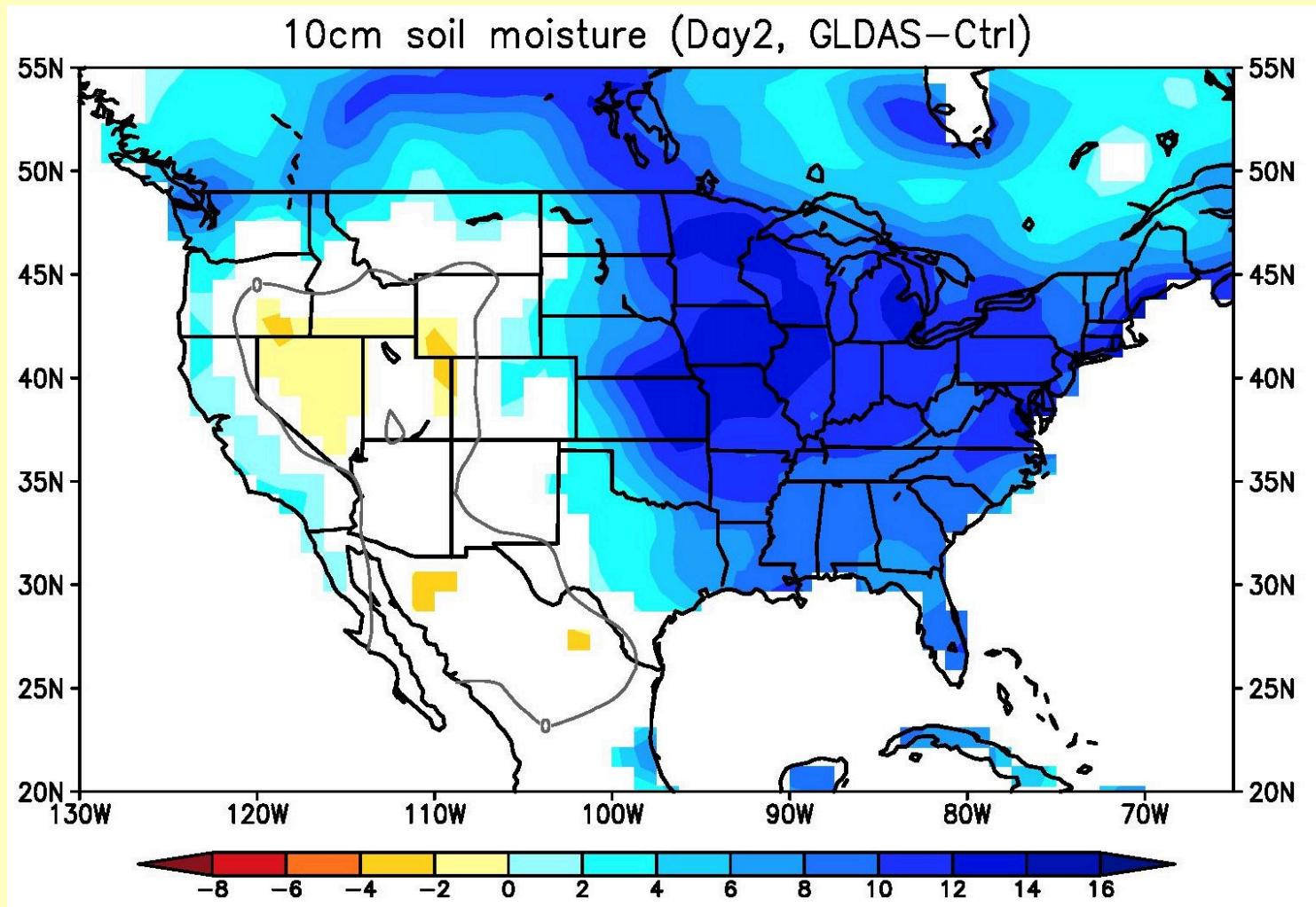
CLM initial conditions for CAPT experiments

- Control: Nudging method (Boyle et al. 2005), nudging start from Jan 2008 (CAM5.1, 0.9x1.25L30)
- GLDAS: CLM offline forced with GLDAS analysis from Jan 01, 1950

CLM restart files are saved as CAPT CLM initial conditions at 00Z every day from the hindcast period

GLDAS: Global Land Data Assimilation System (Fang et al. 2008)

10 CM Soil Water difference (Day2, JJA)



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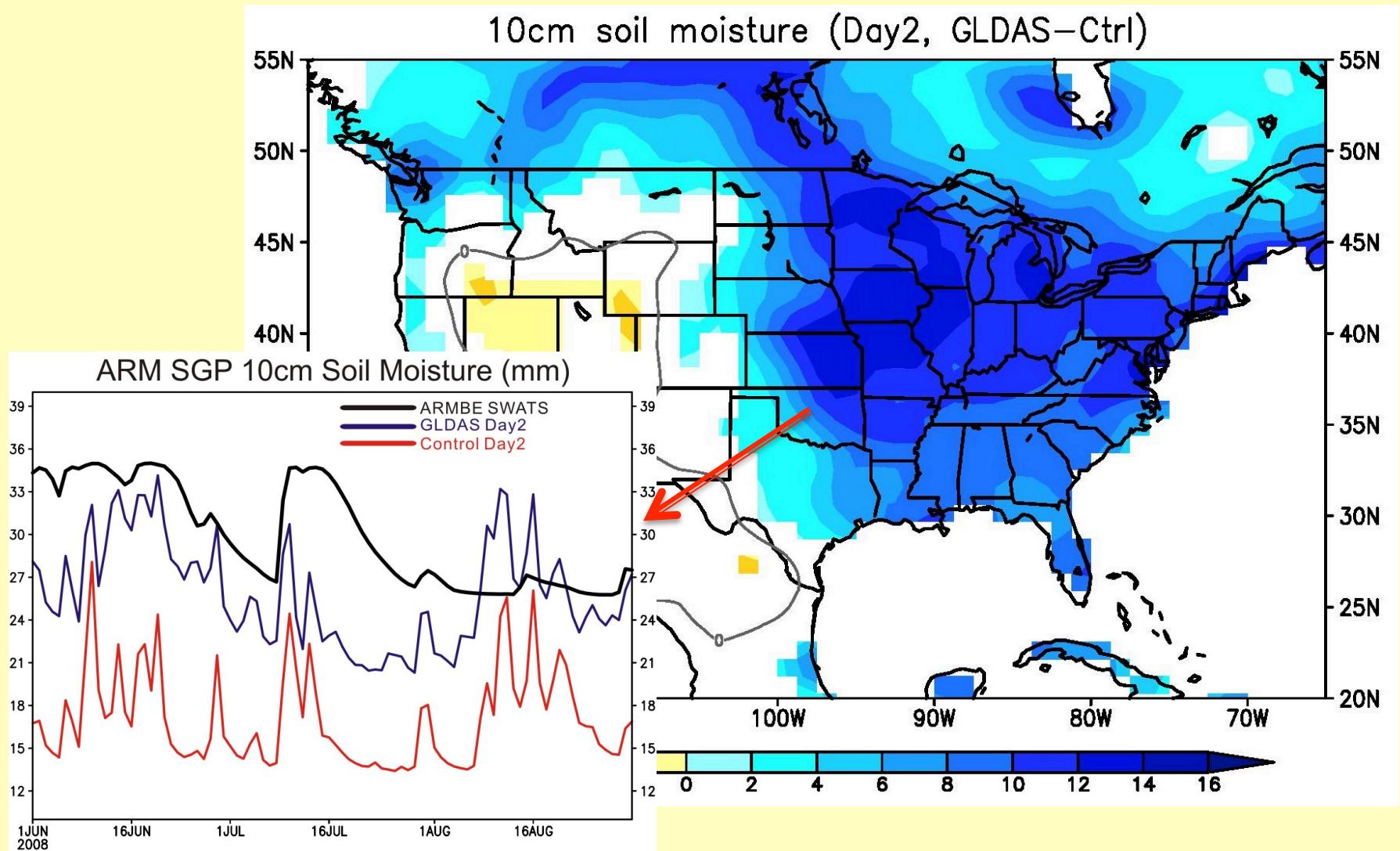


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10 CM Soil Water difference (Day2, JJA)



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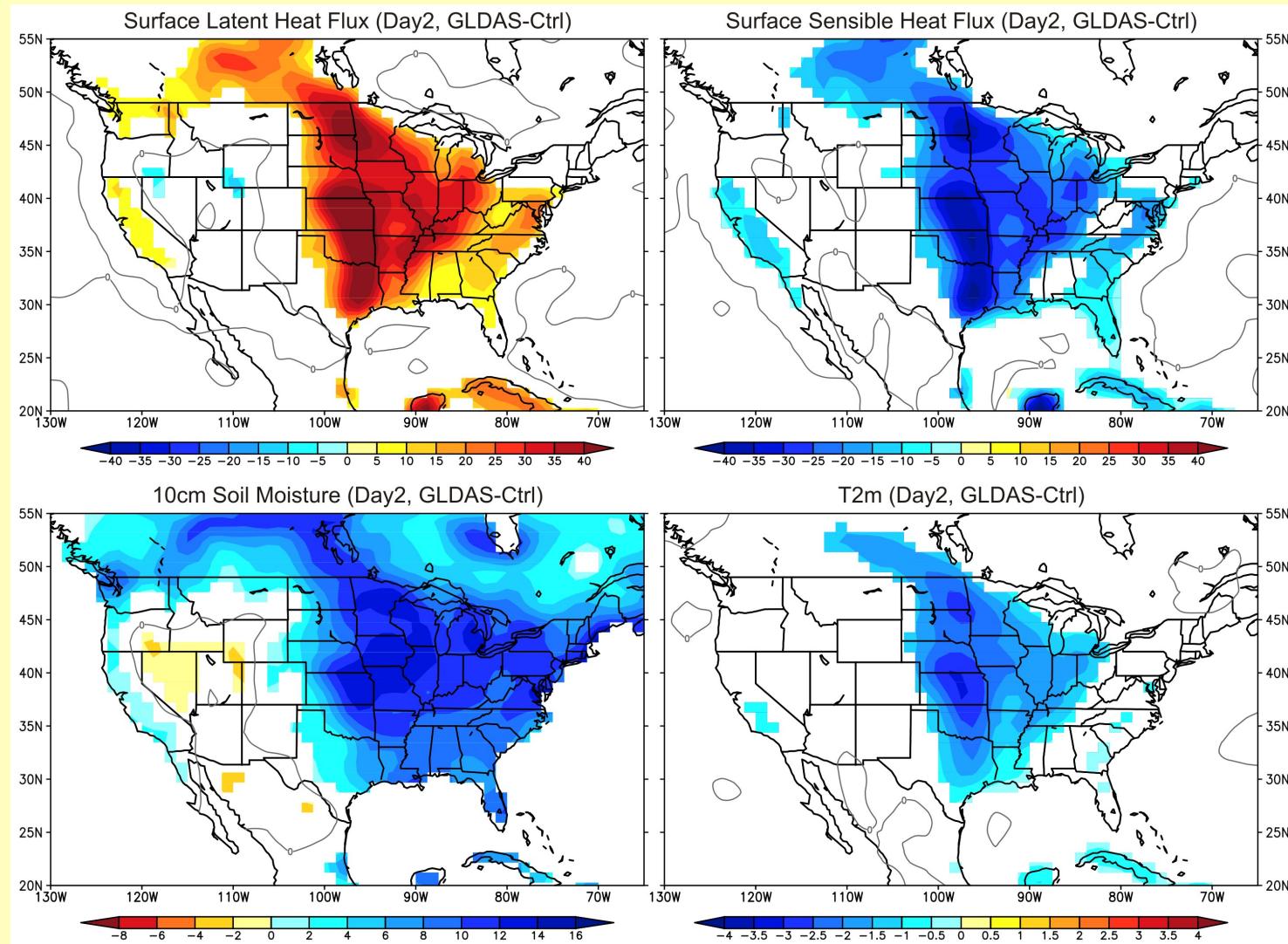


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Surface Fluxes vs T_{2m} (Day 2, JJA)



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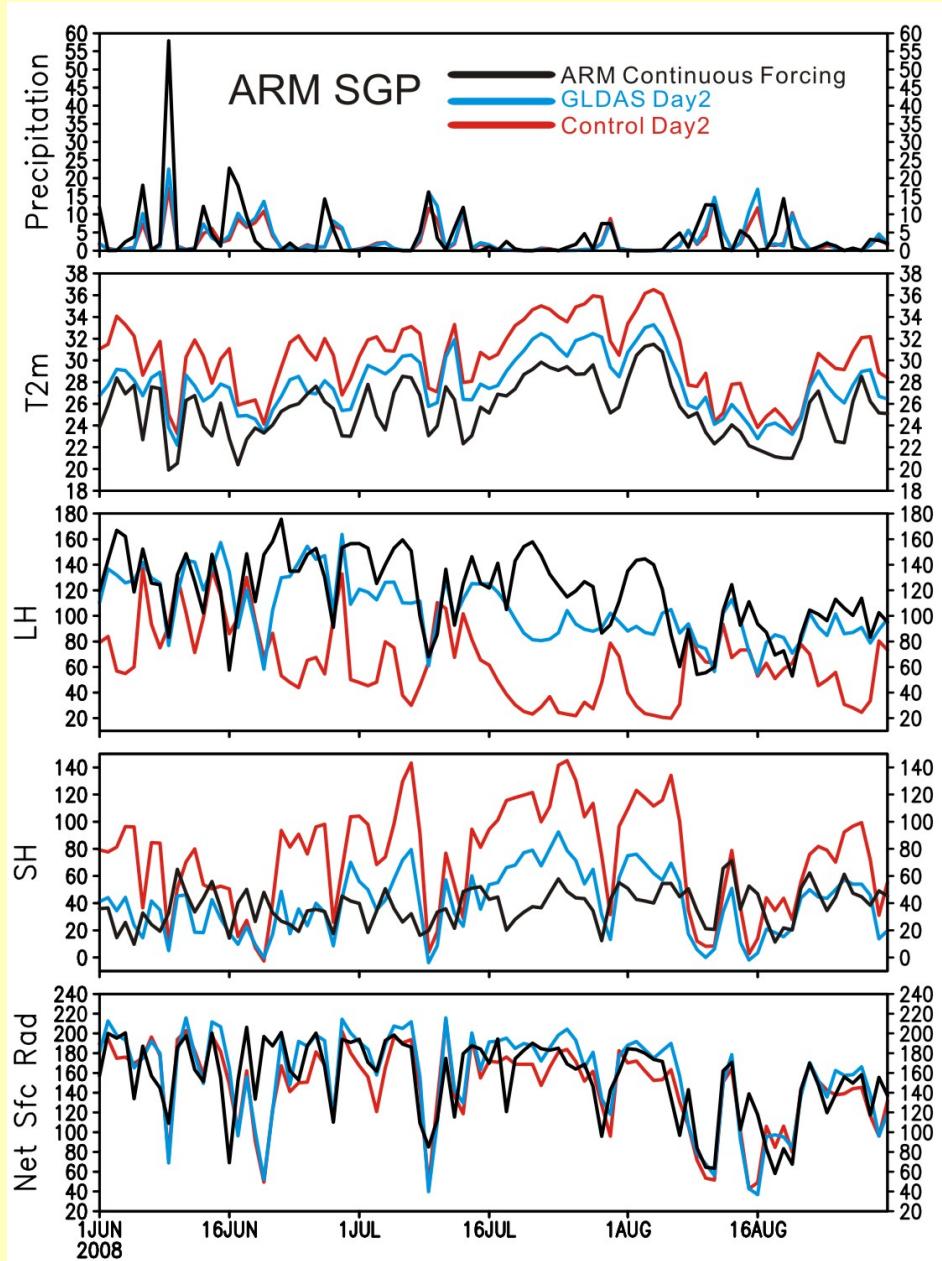


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Surface Fluxes examined by ARM observations at SGP



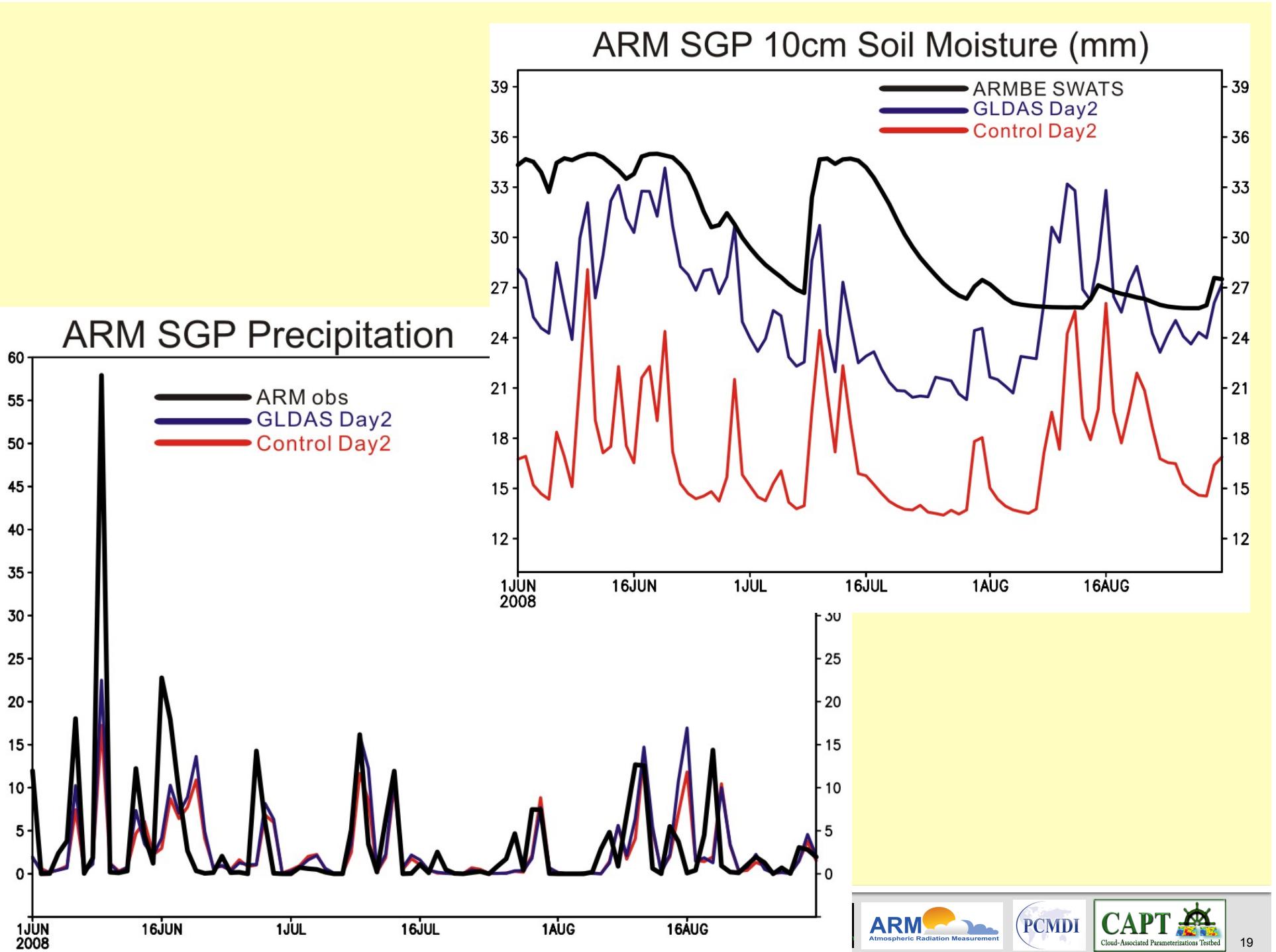
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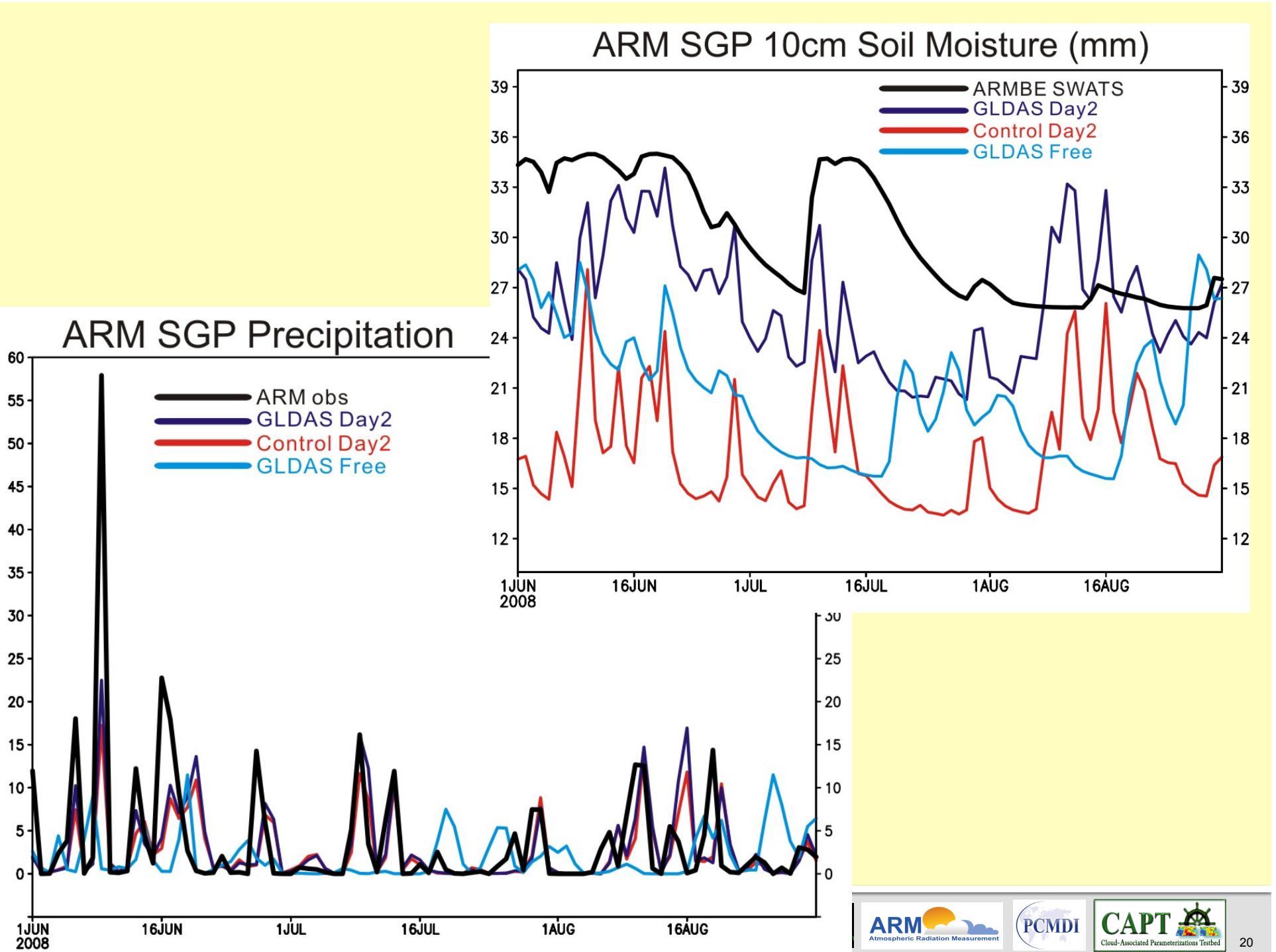


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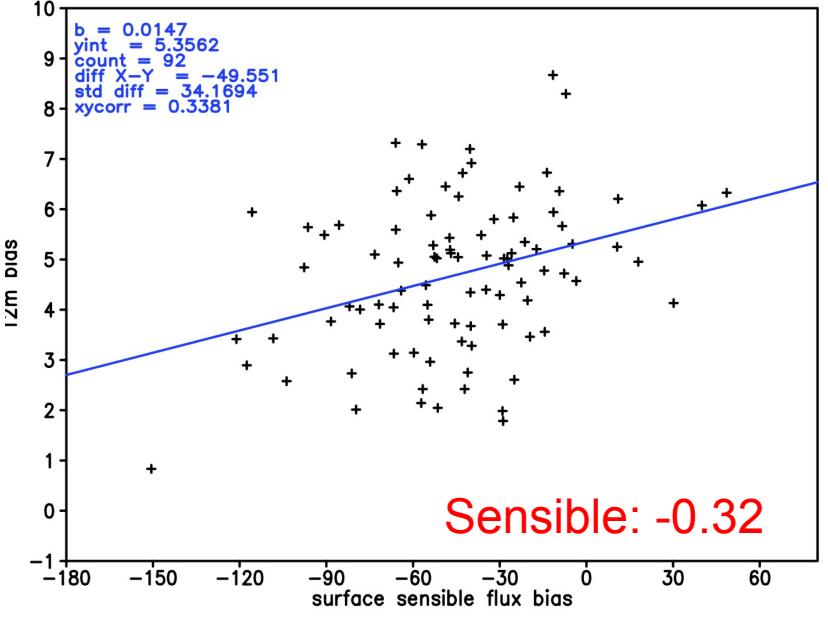
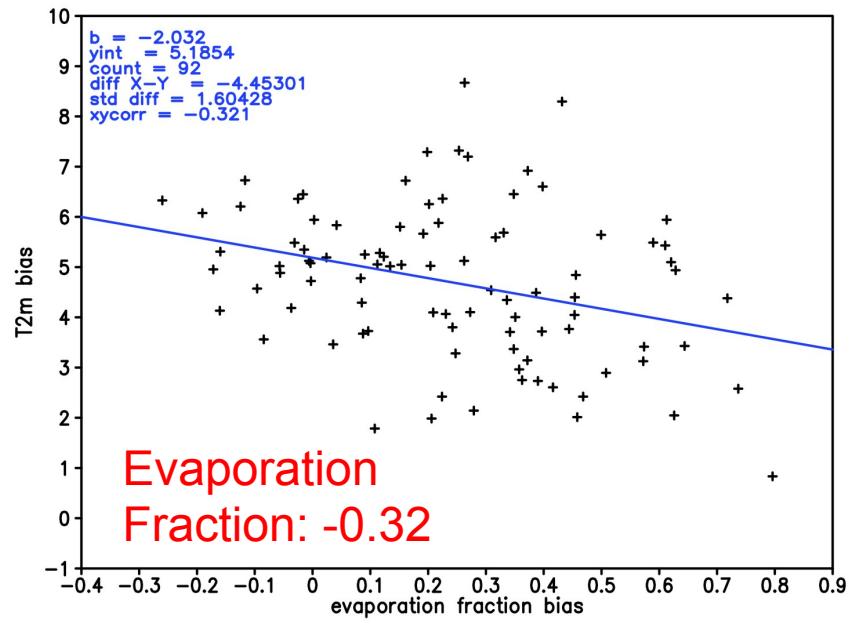
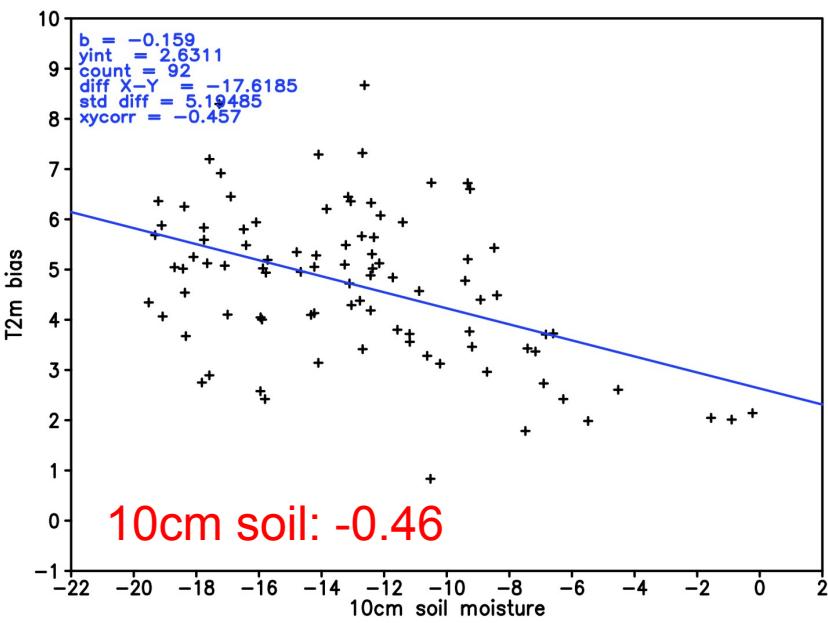
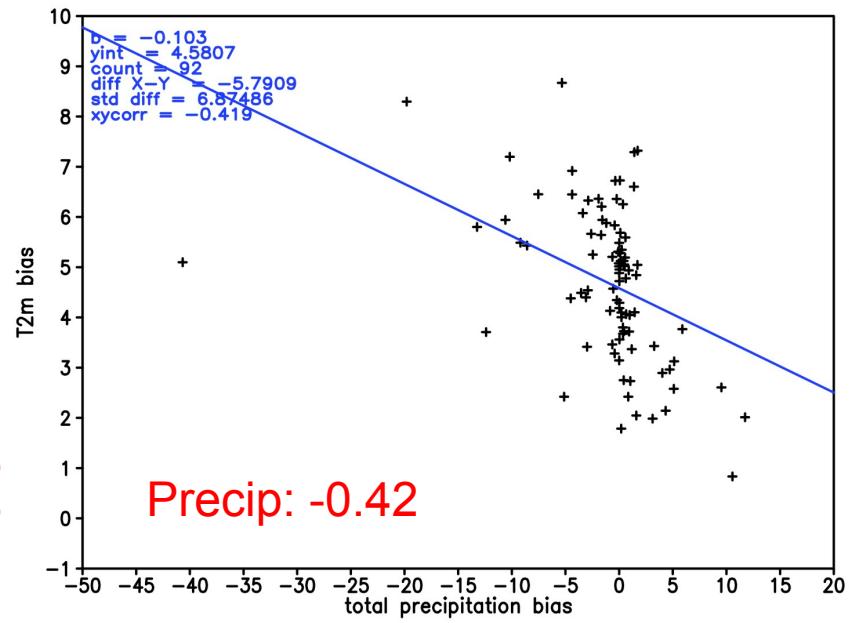
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T2m Bias



Summary and Future Plan:

- Does the surface energy balance reveal signs that evaporation is underestimated due to the lack of soil moisture?
 - The low soil moisture in the land model is likely the cause of surface warm temperature biases.
- Does this atmosphere provide the correct amount of precipitation for the soil?
 - The biased low precipitation is likely one of the key factors.
 - Organization and propagation of convection, or ...?

Summary and Future Plan:

- Additional sensitivity experiments will be carried out to identify the bias contribution from the atmospheric component, land component or atmosphere-land interactions.
- Detailed analysis of T_{2m} biases and surface energy balance terms.